Keep systematic training system design efficient![1]

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Summary

Systematic methods for training system design have been available for years. Using such methods for the development of user requirements and specifications for technically advanced training means (simulators, E-learning, CBT, etc.) ensures that these will fulfil the training needs. The problem is that applying systematic methods takes time and effort, and requires expertise. Our solution is to work iteratively and in workshops under supervision of experienced facilitators. The same systematic method for training system design can be used at different moments with different levels of detail. The SLIM method has been designed for the needs statement phase. In this early stage training needs analysis and training program design are done at a rather global level. Later on, using the same or a similar step-by-step method, the results can be elaborated in more detail, in order to write specifications and -eventually- to implement training. The SLIM method emphasises aspects that are often not systematically addressed: the place of training means in overall training, the choice between high and lower fidelity options, facilities for instruction, feedback and assessment, and the role of the instructors. Inviting all stakeholders ensures that the chosen solution is widely supported. In this paper we briefly describe the SLIM method, and the experiences during its application in a number of different cases. We conclude that needs statements can be developed quickly and systematically using the SLIM method in workshop setting.

[1] Parts of this paper will also appear in Verstegen (in press).

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1. Background

In the Royal Netherlands Army (RNLA) the development of a needs statement is the first phase in the procurement of technically advanced training means such as simulators, Computer Based Training (CBT) web-based learning environments and Virtual Environments. A needs statement describes a preliminary selection of training means and a first estimate of how much they will cost. Of course, it will have to be elaborated, adapted and revised later on. A well motivated needs statement is important, however, as financial, and other resources for these expensive training means have to be reserved well in advance (Verstegen, Barnard, and van Rooij, 1999). Based on discussions with stakeholders from the RNLA, the assignment for TNO Human Factors (TNO-HF) was to develop a method to be used to develop needs statements, or more specifically, to specify a way to determine the present and future training needs within a limited time span and based on information that can be incomplete or insecure, to decide whether and why the acquisition of advanced training means will be necessary, to estimate roughly the resources that should be allocated for this purpose and which other consequences (organisation, logistic and personnel) have to be taken into account.

Field research suggests that currently training needs are often not the major focus during the design of training systems, possibly because those responsible for their specification are usually operational staff or the designers of the operational systems and not the people who are responsible for training. When instructors are involved they are Subject Matter Experts (SME) who have little didactic background and experience with instructional design. The result is that specifications are often technology-pushed and product-oriented, i.e. written in terms of a simulation of the operational system or describing an existing training system seen elsewhere. In other cases, the functional specifications remain vague for a long time, and elaboration in more detail is postponed. This may cause unacceptable delays in the availability of training facilities (Farmer, Jorna, Riemersma, van Rooij and Moraal, 2000; Verstegen, Barnard and van Rooij, 1999; Wallace and Northham, 1998). Using a systematic method can help to avoid these problems.

Different kinds of systematic instructional design and development methods are described in the literature (see e.g. Verstegen, in press, for an overview). None of these methods was directly applicable, however, because they are not specifically geared towards this early phase in the acquisition process, not adapted to the context of the RNLA organisation and not integrated with other RNLA procedures. After an inventory of available method and tools, we evaluated two of them with RNLA target users: the MASTER method (Farmer et al. 1999)[2] and the BOOT decision-making support tool (van der Hulst, de Hoog & Wielemaker, 1999)[3]. The results are described in van der Hulst and Verstegen (2000). The conclusions were that the MASTER method with its many steps and sub-steps is too detailed for the development of needs statements. However, the overall structure of the method is a suitable framework. The second half of the method is specifically geared towards the specification of training simulators, but it seems that the specification of other kinds of training means can take place along the same lines, especially in this early phase. Like the MASTER method, already existing RNLA procedures, for example for the development and implementation of courses, and the design of other kinds of training means, are based on an Instructional System Design (ISD) approach (see e.g. Gagné, Briggs and Wager, 1992). Therefore, we did not foresee major integration problems. The kind of explicit decision-making support offered by BOOT was considered a valuable addition, and was initially implemented by defining explicit decision points with accompanying paper-based checklists. In future, software tools to support decision-making and/or expert systems to for specific decision points may be developed.

One of the problems of the ISD-based approach is that it takes a considerable amount of time and effort to get insight in training system specifications. If it is used too early in the acquisition trajectory the invested

[2] The MASTER method for the specification of training simulators was developed within the European defense research project MASTER (Military Applications of Simulator and Training concepts based on Empirical Research, EUCLID, RTP 11.1).
[3] BOOT stands for decision support for the selection of training means (in Dutch).

time and effort may be wasted, e.g. because the project does not get funding or because conditions change. Waiting too long, however, means that there is not enough time left for thorough analysis of training needs and alternative training solutions. Our solution is to work iteratively, at different levels of detail. In the early stages, training needs analysis training program design and training system specification are done at a rather global level, sufficient to write a well motivated needs statement. Later on, going through the same or a similar sequence of steps, the results can be further elaborated.

Another problem with ISD-based methods is that they are described in a rigid, linear way and need to be adapted to the design project context. Descriptive research indicates that this is not necessarily a problem for professional instructional designers, but is difficult for novices. Moreover, the development of needs statements for advanced training means is a long, complex process involving several parties with different backgrounds and (sometimes conflicting) interests and different kinds of (often contradicting) constraints. Our solution for these problems is to invite all important stakeholders to workshops, which take place under supervision of an experienced instructional designer who organises and monitors the design process, applying the systematic method described Section 2. The participants bring in their own information and expertise and they eventually take the decisions collectively, thus ensuring that the designed solution will be acceptable for all stakeholders.

In Section 2 we will describe our method for the development of needs statements. The method has been applied in five different cases. We will reflect on our experiences during these projects in Section 3, and present some conclusions in Section 4.

2. The SLIM method

The SLIM (Specifying Learning means in an Iterative Manner) method is based on the MASTER method, but adapted for the needs statement phase and the first phase in the acquisition process. The terminology and names of steps have been customised for the RNLA. The SLIM method emphasises aspects that are currently often not systematically addressed: the place of training means in overall training, the choice between high and lower fidelity options, facilities for instruction, feedback and assessment, and the role of the instructors.

2.1 The steps of the SLIM method

The SLIM method leads users through a global analysis and design process step-by-step. This does not, however, mean that the process will always be the same. Depending on, for example, the complexity of the domain and the amount of information available, steps may take more or less time, some steps may sometimes get less emphasis or may only be partly executed. The method consists of four main phases, all divided in sub-steps (see Figure 1):

I. Problem definition: inventory of the intended outcome/results, the demands, available resources and project risks.
II. Analysis of training needs: global analysis of needs for education and training.
III. Design blue print & Selection of training means: design first draft of training and select a suitable combination of training means.
IV. Design of specifications & Cost estimation: definition of global specifications and estimation of the resources that will be required for the acquisition and use of the training means.

Developing a complete and thorough needs statement takes time and manpower. Therefore, the SLIM method starts with an inventory of the situation in order to decide whether it is worthwhile to invest in such an undertaking. This phase is meant as an explicit analysis of the problem situation, as has been observed in the behaviour of expert instructional designers (e.g. Rowland, 1992, 1991; Goel and Pirolli, 1992, 1989). Expert designers have been observed to generate several potential solutions, and not commit to one particular solution until later on. This kind of behaviour is stimulated by asking users to sketch a number of likely training solutions in general terms up front, during the first phase (see also the discussion below). In the second phase a global analysis of the needs for education and training is executed, and in the third phase a

first draft of the course or training program is designed. For the part that will be executed with advanced training means, prototypical lessons/scenarios and types of instruction and feedback are specified. This information is used in the fourth phase to determine global specifications for the required training means (primary user requirements) and other consequences for the training environment, such as the required number and capabilities of instructors, and the additional hardware, software and technical support required for training. This results in a rough estimate of the required resources. Three kinds of resources play a role here: resources for the acquisition of training means, resources for the use and maintenance of those products in future training, and resources for the development of (detailed) specifications. Figure 1 provides an overview of the four phases of the SLIM method and their steps.

The intention of the SLIM method is not to develop final and fine grained specifications, but to start thinking about how education and training will probably take place and which kind of training means will probably be used. On this basis a reasonably realistic cost estimation can be made, taking several alternatives into account. In principle, the same steps of the SLIM method can be executed at a more detailed level later on in the acquisition trajectory. We will come back to this issue in Section 2.4.

2.2 Specific aspects of the SLIM method

The SLIM method proposes solutions for some of the problems with the MASTER method encountered during previous evaluation studies (Verstegen, in press). We will discuss some of these issues below:

a) Dealing with resources
The MASTER method is not entirely clear about when and how designers should deal with information about the resources available for the acquisition and use of training means. The SLIM method starts with an explicit inventory of demands, resources and risks (Step I-2). These are stored in three lists are kept available at all times. After each step users are reminded explicitly to keep these lists up to date.

b) Generating alternatives
As discussed above, users are asked to sketch a number of possible solutions in general terms up front. This is part of Step I-1 and is meant both to make the participants' preconceived ideas explicit and as an inventory of alternative solutions. Comparing alternative solutions comes back as an explicit step half way through the design phase (see below, under point d). For now, it is up to the workshop facilitators to make sure that the participants keep on considering feasible alternatives during the rest of the design process (see Section 4).

c) Explicit decision points
After each step an explicit decision point is introduced. A general checklist with recurring questions or considerations has been developed (e.g. "Are your assumptions still correct?"), and at important decision points more specific questions are asked (e.g. after the selection of training means users are prompted to consider possible alternative solutions).

d) Prioritising and weighing alternatives
To encourage users to consider alternatives they are explicitly asked to select a wide range of suitable training means for each learning activity, and to prioritise these options from most desirable to least desirable (this is part of Step III-2). Subsequently, users select a combination of training means with which all learning activities can be executed, though maybe not all in the most preferred way. Users are advised to envision alternative combinations and to define their advantages and disadvantages, before making a choice. Later on in the acquisition trajectory these alternatives can be reconsidered, for example when the resources do not permit the acquisition of (a part of) the initially chosen set of training means.

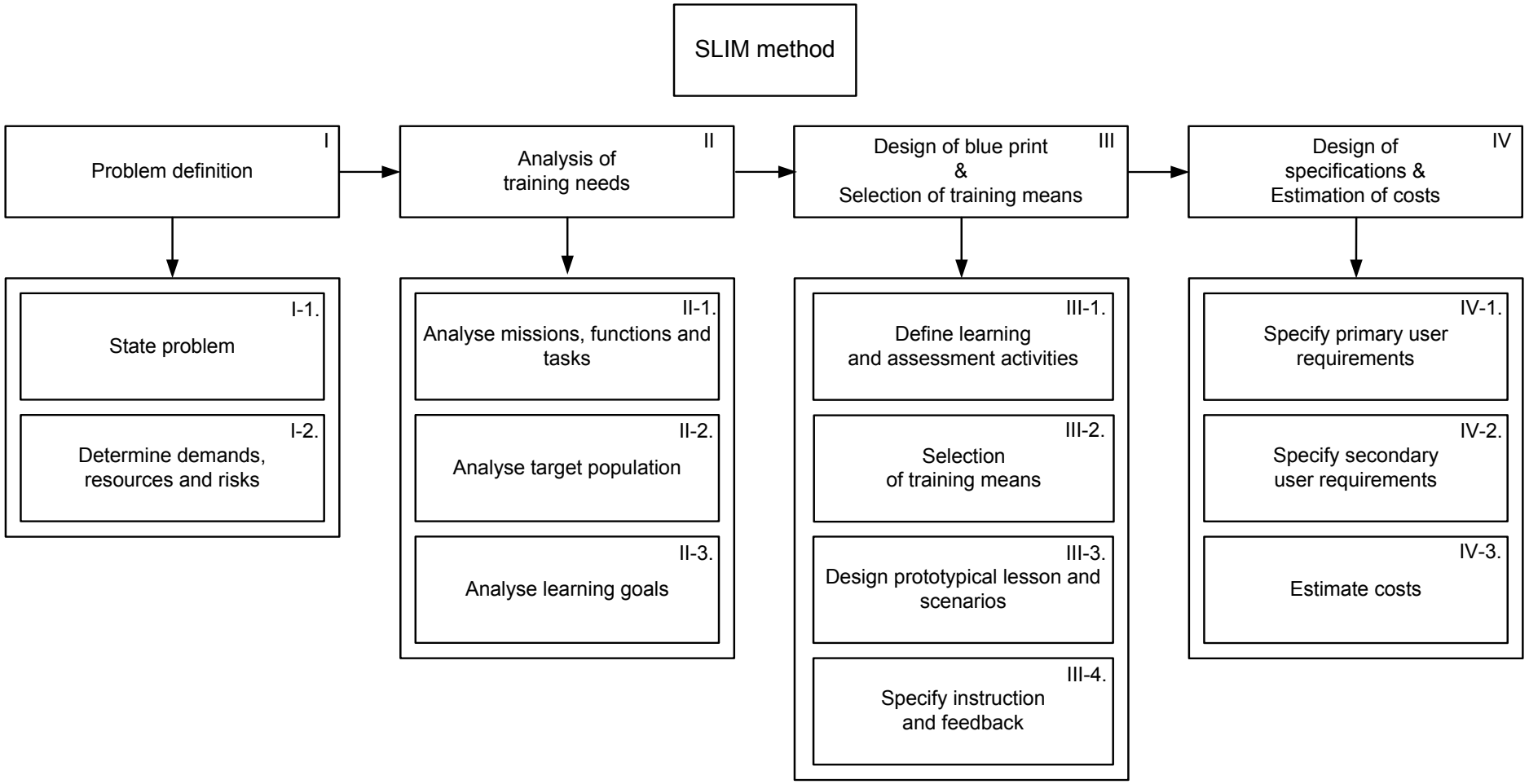

Figure 1: The steps of the SLIM method for the development of needs statements for technically advanced training means.

e) Assessment of the trainees' performance
Evaluations with the MASTER method indicated that assessment planning without an overview of the whole course is difficult, and that there is some overlap between assessment and debriefings (Verstegen, in press). In the SLIM method another point of view has been chosen: assessments are regarded as a special category of learning activity and are planned in the same step. Subsequently, they are elaborated in the same way, i.e. a range of suitable training means is chosen and, if the assessment activity is allocated to advanced training means, a 'scenario' for the assessment is described in step III-3.

2.3 Applying the SLIM method in workshop setting

The SLIM method has been applied in the form of workshops with all stakeholders under supervision of two experienced facilitators. In this setting, the workshop leader is fully responsible for the management of the design process: explaining the goals of the SLIM method, organising the process, structuring and guiding the discussions, making sure that no available information is neglected and that all feasible alternatives were taken into account, deciding when to go to the next step and also when iteration is necessary. A second facilitator takes notes and is responsible for the documentation of the entire process.

The role of the workshop participants is to provide the necessary problem and domain information, and to make decisions. Ideally, the number of participants is between four and eight, including at least a domain expert, a course designer, a future instructor and a representative from the school's management. It is also possible to invite other stakeholders, such as a representative of the operational unit(s) where trainees will work in future, a CBT developer, or financial and technical experts. Too many participants is expected to make the workshops inefficient. On the other hand, inviting all stakeholders ensures a widely accepted solution.

Iteration is encouraged by organising a sequence of workshops. In between workshops the participants can reflect on the results so far, collect additional information and discuss with their colleagues. New information or discussion points are input for the next workshop, and thus taken into account immediately.

2.4 Reusing the results of the SLIM method

The SLIM method is meant to be used at a global level of detail. Initially training needs analysis, training program design, and training system specification are executed at a rather global level, sufficient to write a well motivated needs statement. The description of steps, the guidelines, checklists and other support are focussed on helping users to go through the steps in a limited amount of time (allowing iterations, see Section 2.3). At the same time it ensures that the information collected during the first phase of the acquisition process can be reused later on when specifications are developed at a more detailed level as depicted in Figure 2.

In principle, the same steps of the SLIM method can be executed at a more detailed level later on in the acquisition trajectory, e.g. to develop functional specifications, technical specifications and, eventually, to develop and implement training. Alternatively users can choose for a more specific and detailed ISD-based method, such as the MASTER method for developing simulator specifications.

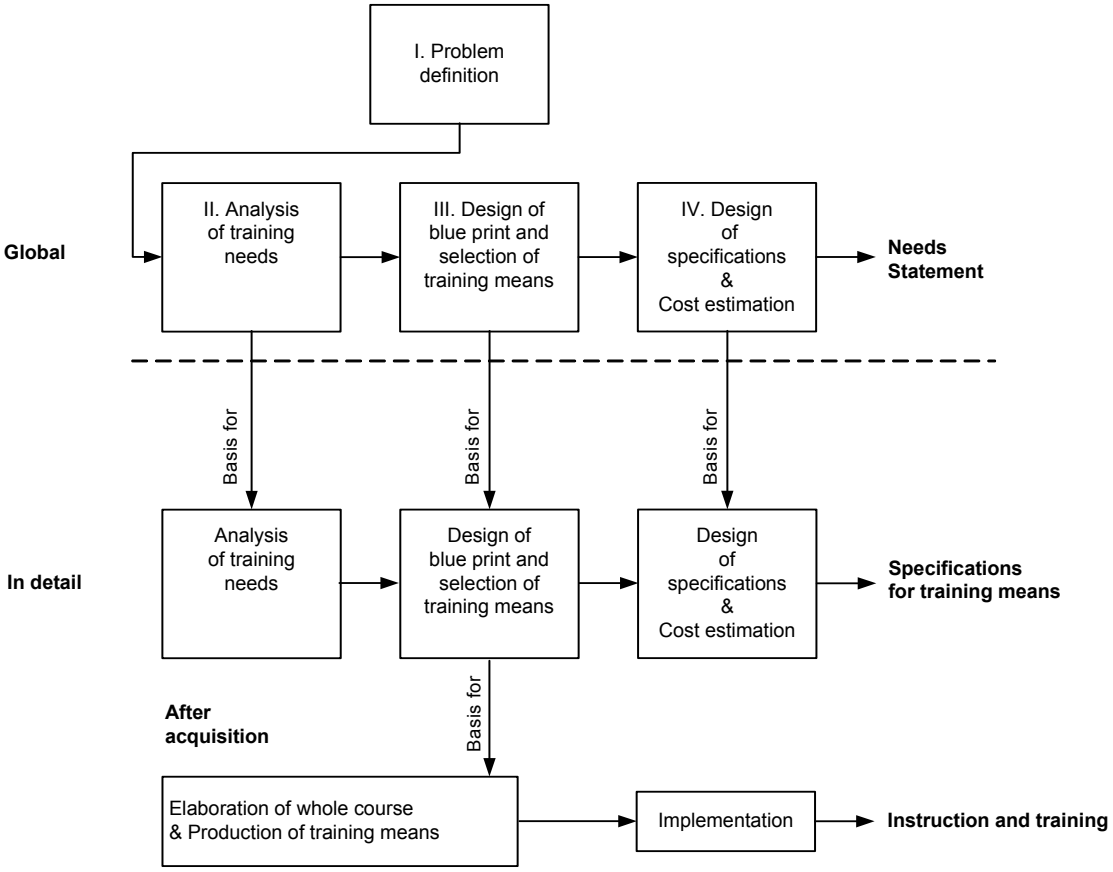

Figure 2: Reuse of information collected with the SLIM method.

3. Experiences with the SLIM method

In this section we will report our experiences with the SLIM method. After discussing the five cases in Section 3.1 we will discuss how the SLIM method was applied and adapted in Section 3.2, reflect on the role of the facilitators in Section 3.3, and briefly address iteration and dealing with uncertainty in Section 3.4.

3.1. The five cases

We have applied the SLIM method in five different cases with customers, three times for the RNLA, once for the Royal Netherlands Navy and once for the Royal Netherlands Air Force. For the last two cases, we adapted the terminology and the names of the steps to those used in these organisations. The results presented below are based on the written reports that were made of all the sessions (Boot, Verstegen and Veerman, 2002; Melis and van Berlo, 2003; Verstegen, Veerman and van der Arend, 2001), the discussions with the participants during the sessions, and the experiences of the facilitators.

In three of the cases, the resulting needs statement describes a CBT application, in one case a desktop-based simulation and in one case a simulator (all to be used in combination with other training means). All five cases were complex, but for different reasons. In one case the main source of complexity was the fact that the operational system did not yet exist, and that the information about the exact nature of the tasks that trainees would have to be trained for was incomplete and insecure. In another case the tasks were relatively easy, but the complexity from an educational point of view was caused by the very large number of trainees to be trained for different subsets of tasks. In two cases, the same training means would have to be used by clients from two rather different organisations who were planning to use the same operational system in different ways; there were also some differences in organisational culture, capabilities of instructors and the

characteristics of target trainees. In both these cases, an additional complication was that the assignment of the participants of the workshop was to design CBT to be used in combination with a simulator that was being specified at the same moment by a different group (with some overlap in participants). And in one case, the course addressed during the workshop was meant to be just an example to investigate the potential role of simulation-based CBT. The challenge in this case was to incorporate an existing instructional design model for maintenance training and to replace (part of) the practice with simulators and/or operational systems with CBT-based exercises.

Since the complexity of the cases differed, the amount of time required to execute the SLIM method differed as well. The case studies took four to seven days divided over two to four sessions. In between sessions the participants went back to their workplace to collect more information and discuss the results with their colleagues. In some cases, the workshop participants took away 'homework', i.e. further elaboration of steps to be done independently in between sessions. In other cases participants were not able and/or willing to do this. It should be noted that the level of detail of the results differed as well, mainly because the amount of time available for workshops was limited by project boundaries.

3.2. The SLIM method applied to different cases

We had expected to have to adapt terminology for non-RNLA participants (see above). However, during the workshops it became clear that in all cases participants misinterpreted some terms, or used them in slightly different ways. When miscommunications hindered the process, terms were redefined on the fly or replaced by terms that were better known by the participants. In some cases the method was slightly customised as well, e.g. combining steps three and four in the design phase in a less complex case, or leaving out the fourth phase because it was not the responsibility of the workshop's participants. This ad-hoc customisation was experienced as an advantage of applying the SLIM method in a workshop setting in direct contact with the stakeholders, but it requires considerable effort and skill from the facilitators (see Section 3.3).

Applied in this way, the SLIM method proved to be robust and versatile enough for all five cases. In the experience of the facilitators the method was a valuable instrument in structuring the development process and maintaining focus and consistency. The participants valued the structured approach of the SLIM method, but clearly preferred not to be bothered with details regarding the SLIM method or instructional design and development theory in general.

Note that in this format, the participants take all the final decisions. This means that the SLIM method works towards a solution that suits the organisation and is accepted by all stakeholders, which can be –but is not necessarily– innovative. The acquisition of training means had to solve existing or expected problems of the organisation. Sometimes new types of training means were required, e.g. because the participants expected that they would have much less opportunity to let trainees practise with the operational system in future. In one case, innovation was explicitly the goal of the workshops (i.e. simulation-based CBT, see above). In another case, however, the participants decided that for a new course classroom based lessons were most suitable, much like the classroom based lessons in existing courses at the school. Another observation was that the participation of all stakeholders is vital. In one of the cases not all stakeholders were present during the workshops, which lead to uncertainty and speculation about 'what they would want', and extra time investment in reporting the results of the workshops, getting feedback and adapting the results accordingly.

3.3. The role of the facilitators

The role of the facilitators is important. The workshop leader needs to be familiar with instructional design and development models in general and with the details of the SLIM method, since he or she has to take care of organising and managing the process. The interaction can be quite unorganised, sometimes almost chaotic, since the workshop participants do not (and are not meant to) pay attention to the SLIM method and the development process. It is the task of the workshop leader to introduce the different activities (i.e. steps of the SLIM method) and to help the participants to complete the different tasks. The workshop leader also has

to maintain an overview of what needs to be done, and decide when to go to the next step or back to a previous step. On top of that, the workshop leader decides if the terminology and the SLIM method need be customised, and how this can be done without violating the important principles underlying the method. The second facilitator, who is responsible for the report, also needs to be familiar with the SLIM method in order to be able to summarise and reorganise data that may result from different moments in time according to the steps of the method.

In most cases there were participants with different backgrounds and conflicting interests, and some overpowering personalities. Participants have different positions in the organisation's hierarchy, and often existing political problems played a role. The workshop format proved to be an efficient way to collect all available information, make the different opinions and arguments of stakeholders explicit, and come to joint decisions. The workshop leader, however, needs additional skills to manage these group dynamics.

It proved to be important to state the roles of the facilitators and the workshop participants clearly. In principle, the facilitators guide the process and the participants take the decisions. Only on request did the facilitators bring in their own knowledge and experience in the field of instructional design and development. Sometimes, however, giving examples proved to be a good way to get a discussion going or to stimulate the participants to consider alternative solutions.

In three cases, the participants had very high expectations of the knowledge available in the area of instructional design, illustrated by remarks such as: "So, just tell us which learning goals need CBT", "I'm sure there has been done a lot of research about how to teach these tasks", and "There must be ready-made solutions described in literature". The same phenomenon was observed in other settings, for example during evaluations of the MASTER method with target users (see e.g. van Rooij et al., 1998; Verstegen and van der Hulst, 2000). However, like other instructional design tasks, the development of a needs statement is an ill-structured problem for which there is, usually, no guaranteed best solution or solution procedure. Which combination of training means or instructional products is suitable depends not only on educational factors, but also on pragmatic factors such as the available budget, the amount and capabilities of the instructors, etc. There are no ready-made solutions available that take all these factors into account. This was an eye-opener for many participants.

3.4. Iteration and dealing with uncertainty

In all cases there was iteration within the period dedicated to the development of the needs statement, usually caused by the fact that the required input for a later step was incomplete or not elaborated into enough detail or because of new information from sources or people not present at the workshop. Sometimes, participants phoned colleagues during the workshop for missing input information. In one case, the participants proposed to split of the first phase (Problem Statement) into a one-day workshop, followed by an interval to collect additional information. The participants were less inclined to iterate in order to improve their design or to consider alternative solutions.

Uncertainty played a role in all cases, but for different reasons. In the case where the operational system did not yet exist there was much uncertainty about the tasks, especially the division of tasks between team members and the learning difficulty of the tasks. In another case the source of uncertainty was an ongoing reorganisation with -as yet- unknown consequences for the division of tasks over personnel. In a third case, the participants' task was to develop a needs statement for CBT to be used in addition to a simulator for which the specifications were being developed simultaneously by other people. However, it was not yet clear what the capabilities of the simulator would be, and indeed not even whether the simulator would be bought or not. In the fourth case, the main goal of the workshops was to develop guidelines for the application of CBT in the school. During the workshop an example course was used, and it was not clear whether CBT would be necessary or (financially) feasible for this course. And in the fifth case, most uncertainty was caused by the fact that not all stakeholders were present during the workshop.

4. Conclusions

With the SLIM method used in a workshop setting a needs statement can be developed quickly and systematically. With experienced facilitators the SLIM method is robust and applicable to different kinds of cases in different settings. During the workshops the different aspects of the design task were split up: the workshop leader organised and managed the development process, and guided the development activities and the communication between the participants. A second facilitator was responsible for the documentation process and products. Thus, the participants could focus on bringing in their own information and expertise, and on making decisions. This proved to be effective form of process management, but requires skill and expertise of the two facilitators. Inviting all stakeholders ensures that all arguments will be taken into account, and that the selected solution will be accepted within the organisation. In fact, this format can be seen as a combination of a systematic and a relational or communicative approach, as advised by Kessels (1999, 1993), amongst others.

Working with a group, rather than individually, seemed to make the process more complicated: there were almost continuous 'interventions' caused by discussions between workshop participants or by new information brought in by one of them. In most cases the most important stakeholders were present, though iteration was also caused by information or opinions from other people collected between sessions. The SLIM method provides a framework, that ensures that all important issues are systematically addressed. It also helps to manage the iterative design process. When participants bring in new information, the workshop leader decides to discuss it immediately or to come back to it at a later moment. The second facilitator makes sure that it is documented with the right step in the report. Working with a group also introduces a social aspect to the development process: during discussions not only rational arguments played a role, but also personal interests, personalities, differences in rank or power, existing conflicts or power struggles (between individual people or between different parts of the organisation), differences in interaction styles, and so forth. The workshop leader needs additional skills to manage these group dynamics. It is possible that GroupWare systems could support this aspect of the development process during the workshops.

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